Comp 0.121

ANNUAL REPORT

LAKE STATES FOREST EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

E. L. DEMMON, DIRECTOR

1947

MAINTAINED IN COOPERATION WITH
UNIVERSITY OF MINNESOTA
UNIVERSITY FARM, ST. PAUL 1, MINNESOTA

Lake States Forest Experiment Station

ANNUAL REPORT FOR 1947

TABLE OF CONTENTS

	Page
Facts about Lake States forests.	ii
Introduction	1
Lumber.	1
Pulpwood.	2
Integration of wood use	3
Aspen	3
Other forest problems	4
Experimental forests as demonstration areas.	5
Forest Economics	6
Forest survey of northern Minnesota	6
Forest survey of Michigan	7
Region-wide growth studies.	8
Forest industry wood needs.	9
Problems of landownership in northwestern Wisconsin	10
Financial aspects of growing and harvesting spruce pulpwood	11
Forest Management.	13
Forest fire research.	13
Optimum stocking for northern hardwoods under the selection system of management	
Thinning and pruning in young second-growth hardwoods	17
Management of farm forestry forties in second-growth hardwoods.	18
Reforesting poorly drained areas.	19
Plantation release by use of chemicals.	19
Chemical weed control in forest nursery	20
Forest influences--field shelterbelts.	20
Cooperative farm forestry.	21
Michigan.	21
Wisconsin	21
Minnesota	22
Forest wildlife research	23
Porcupine damage to forests	23
Effect of moose on the vegetation of Isle Royale National Park.	23
Articles published in 1947	25
Personnel.	30

FACTS ABOUT LAKE STATES FORESTS

	MICH.	MINN.	WIS.	LAKE STATES
Forest Area by Ownership (1945)		Millions of acres		
Federal	2.4	3.1	1.8	7.3
State and county	4.7	8.4	3.8	16.9
Farmer	3.8	5.4	6.6	15.8
Other private	8.1	2.8	4,8	15.7
Total	19.0	19.7	17.0	55.7
Saw-timber Volume (1945)		Billions of board feet		
Softwoods	7.4	5.0	3.3	15.7
Hardwoods	16.7	6.6	11.7	35.0
Total	24.1	11.6	15.0	50.7
Pulpwood Volume Excluding Saw Timber (1945)		Millions of cords (with bark)		
Spruce and balsam	7.5	9.4	2.2	19.1
Pine	1.3	3.8	1.5	6.6
Hemlock	6.1	...	1.6	7.7
Aspen	16.2	16.8	9.8	42.8
Total	31.1	30.0	15.1	76.2
Annual Saw-timber Drain (1935-44)		Millions of board feet		
Softwoods	274	202	294	770
Hardwoods	527	158	363	1,048
Total	801	360	657	1,818
Estimated Allowable[1] Annual Cut of Saw Timber (1946-55)		Millions of board feet		
Softwoods	170	163	67	400
Hardwoods	400	227	273	900
Total	570	390	340	1,300
Annual Drain of Pulpwood Excluding Saw Timber (1935-44)		Thousands of cords (with bark)		
Spruce, balsam, pine, hemlock	609	479	561	1,649
Aspen	172	343	185	700
Total	781	822	746	2,349
Estimated Allowable[1] Annual Cut of Pulpwood (1946-55)		Thousands of cords (with bark)		
Spruce, balsam, pine, hemlock	395	375	175	945
Aspen	890	800	350	2,040
Total	1,285	1,175	525	2,985

1/"Allowable Cut"means cutting that will improve future growth possibilities.

Lake States Forest Experiment Station

ANNUAL REPORT FOR 1947

INTRODUCTION

Forest research should be closely geared to forest conditions within the region. In reviewing progress and in making plans for future investigations, it is important, periodically, to take a fresh look at the forest situation. What is the current extent and condition of the forest, who owns it, what is the annual growth in terms of various commodities and for particular forest areas, and how fully do these meet present and prospective needs? Information on these as well as other forestry questions should be considered. The statistics on the preceding page summarize a few basic facts on the current forestry situation in the Lake States region.

During 1947, two factors had an important bearing on the Lake States forestry situation: (1) the high demand for lumber, particularly to meet the housing shortage, and regardless of greatly increased lumber prices; and (2) the impending shortage of available pulpwood due to announced embargoes on pulpwood exports from Ontario.

Lumber

The continued heavy demand for lumber has stimulated excessive cutting of second-growth timber, both hardwood and softwood. The region's old-growth forests, mostly hardwoods, are already nearly cut over. The remnant, about one million acres of old-growth northern hardwood and hemlock, is important far beyond its actual acreage in sustaining veneer mills and a few large sawmills. Future lumber production, however, will be dependent upon the second-growth forests that have followed the logging of the original stands, and these are as yet short of merchantable-sized material. An important question is whether this second-growth will be permitted to stand long enough to produce saw timber in quantity, or will it be slashed off as soon as it reaches minimum merchantable size?

Heavy cutting in young stands of pine is even more damaging to future growth than in hardwoods. After three-quarters of a century of continuous logging and many destructive forest fires, the pine forests of the Lake States (originally covering 24 million acres but now reduced to 4 million) can no longer supply more than a fraction of local needs for softwood lumber. The second-growth pine stands now contain a far smaller proportion of conifers than did the original forest. And the cutting pressure on softwood stands is too heavy to permit much building up of growing stock.

Largely because of overcutting and past fires, the Lake States forests (hardwoods and softwoods together) can supply for the near future only about 40 percent of the regional saw-timber needs. The balance must be imported, mostly from the West Coast. The future, however, can be bright.

If the Lake States forests are restored to something approaching full productivity, current yields can be more than doubled. The region could become essentially self-sufficient for lumber if present rates of consumption did not increase materially.

To help solve some of the more immediate problems in this field, the Station is trying to learn:

1. How to prolong the life of existing mature hardwood stands by systems of partial cutting.

2. How much second growth there is in various parts of the region and how fast it is becoming merchantable.

3. What the financial returns are under different methods of timber management, both for small tracts representing farmer ownership as well as for large operations.

4. How to obtain ample forest reproduction and stimulate growth of softwoods in pure and mixed stands.

5. How to reforest denuded lands successfully and at lowest cost.

6. How to secure better protection from fire.

Pulpwood

Many Lake States pulp mills have come to depend upon Canadian sources for a considerable part of their pulpwood needs, particularly spruce. In recent years, roughly one-half of the spruce consumed in Lake States pulp mills has been imported from Canada (mostly from the Province of Ontario). Following the recommendations of a Royal Forestry Commission, the Provincial Government of Ontario, in the fall of 1947, announced drastic curtailment in the export of pulpwood to the United States, to become effective during the next few years. Thus, the pulp and paper mills of this region are faced with the problem of how to meet future needs of pulpwood from their own region.

This could lead to additional misuse of the forest by premature cutting in young stands which would further deteriorate Lake States forests for years to come.

Several courses of action are possible:

1. A greater proportion of pulpwood needs could be met by imports from Rocky Mountain forests.

2. Pulpwood operators could reduce waste and effect closer utilization in woods operations in the Lake States.

3. Pulping processes could be altered to make greater use of aspen and hardwoods.

4. Local forest yields could be increased through better forestry, such as by thinning of young stands and utilizing such material to a smaller size than heretofore.

The Station is interested in all these possibilities which, in essence, mean better forestry on all fronts.

The Station endeavors to aid in solving pulpwood supply problems by keeping abreast of and furnishing up-to-date statistics on the supply and use situation, by studies leading to closer utilization and improved management of young stands. One experimental tract of nearly 2,000 acres in Wisconsin will be devoted primarily to problems of pulpwood production, and arrangements for the use of another area of about equal size are being made with the State of Minnesota. Studies of reforesting denuded lands have been under way for some years.

Integration of Wood Use

Many problems of lumber and pulpwood production are related and also have some relation to those of other forest industries in the region. Because of varied landownership and mixed composition of timber stands, integrated use is essential to get the most out of the forests. Certain types of forest, particularly those with a large proportion of swamp species, are better suited for pulpwood than for any other product, and it is logical that forests owned by pulp and paper companies will be primarily devoted to growing pulpwood. However, pulp and paper company holdings also include considerable hardwood and pine of more value for poles and piling or for veneer logs than for converting into pulp. Lumber companies and veneer companies own quantities of small spruce, balsam, and jack pine suitable for pulping. Pulp mills can utilize large quantities of wood from the smaller trees, the tops, and from trees which are not suitable for other purposes. The answer to good Lake States forestry does not mean production for any one use alone, but for integrated use.

Prevailing prices for red pine stumpage in Minnesota, at the end of 1947, illustrate the advantage of integrated utilization. Pulpwood was bringing from $1.50 to $3.00 per cord, sawlogs (using a converting factor of 3 cords per thousand feet) brought $5 to $17 per cord, poles from $8 to $10 per cord, and piling $12 to $17 per cord. It goes without saying that not all trees are of a quality that will command the higher prices, hence the greater need to cut them into the use for which they are best suited.

The Station is planning a study of financial yields, to compare returns from cutting for different products at different stages of timber growth.

Aspen

One bright spot in the Lake States forest situation is the wide availability of aspen or popple. Aspen, especially of pulpwood size, far exceeds the current demand. The most accessible stands and those of high quality find fairly ready sale, but much aspen is rotting on the stump. In an effort to obtain greater appreciation and use of aspen, a Lake States Aspen Committee was formed in early 1947. It was made up of representatives of various agencies familiar with the properties, utilization, and management of aspen. The committee divided up the job of preparing 21 reports summarizing what is currently known about aspen. At the end of 1947, 13 of these had been issued, under the sponsorship of the Station. A great deal of interest has been expressed in these reports, and the 8 remaining reports should be available by July 1948.

Aspen Reports

Report number	Subject
*1	Aspen Properties and Uses
*2	Aspen Availability and Supply
3	Logging Methods and Peeling of Aspen
*4	Milling of Aspen into Lumber
*5	Seasoning of Aspen
6	Aspen Lumber Grades and Characteristics
*7	Mechanical Properties of Aspen
*8	Machining and Related Properties of Aspen
*9	Aspen Lumber for Building Purposes
*10	Aspen for Containers
*11	Aspen for Core Stock.
12	Small Dimension and Other Industrial Uses of Aspen
13	Aspen for Veneer
*14	Aspen for Pulp and Paper
*15	Aspen for Cabin Logs
16	Aspen for Excelsior
17	Aspen Defiberization and Refining of Product
*18	Chemical Utilization of Aspen
19	Preservative Treatment of Aspen
20	Marketing of Aspen
*21	Possibilities of Managing Aspen

*Issued during 1947.

Other Forest Problems

While major Station emphasis has been given to forest management and forest economics problems, it has not neglected other important phases of forestry. Forest wildlife problems are under cooperative study by the U. S. Fish and Wildlife Service, a wealth of material on the influence of forests on watershed protection and wind erosion is being analyzed, and many management and economics studies bear indirectly on the enormous value of Lake States forests for recreation and inspiration.

Although research progress has been made at Station work centers in northern Minnesota and northern Wisconsin, and on a smaller scale in the Upper Peninsula of Michigan, many regional forest problems are still untouched. Research at each of the areas mentioned above needs strengthening, and research centers should be provided for Lower Michigan, southern Wisconsin, and southern Minnesota. The resurvey of the forest resources of the Lake States should be speeded up and brought to an early conclusion. Also, a forest utilization service unit should be provided for this region similar to those already set up in all other important forest regions in the country. Such a service would help solve important utilization problems on the ground as well as bring to the Forest Products Laboratory at Madison, Wisconsin, problems needing solution there.

EXPERIMENTAL FORESTS AS DEMONSTRATION AREAS

During the war, relatively little use was made of experimental forests for demonstration purposes. Public travel was restricted and time of resident personnel, apart from timber sales and more urgent duties, was not available to show people around. The year 1947 has seen a reversal in this trend and a decided increase in number of visitors. In spite of the fact that only selected small groups were invited to visit the experimental areas and no generally publicized field days were held, 684 individuals visited the Station's tracts. Technical foresters from public and industrial forests and timber operators made up the largest proportion of visitors, followed by students of forestry and conservation, and, finally, sportsmen and lay conservationists.

The Station is not equipped with sufficient personnel and facilities to conduct large-scale public meetings and field demonstrations of forest practices. Instead, it is believed best to work with smaller but selected groups who can directly apply the results of experimental work on forest properties. In this way the Station's primary effort can be devoted to carrying forward research activities. An important phase is the prompt writing up and publication of technical results for the use of technicians and administrators of public and private forests. A list of such articles published during 1947 is given at the end of this report.

The Station's field-research program is largely centered on its experimental forests, listed in the following table:

Research Center and location	Experimental forests	Representative forest types		Net area in acres
		Major	Other	
Headwaters (Northern Minnesota)	Cutfoot	Jack and red pine	Mixed pine	3,049
	Pike Bay	Aspen	Hardwoods and balsam	3,940
	Kawishiwi	Jack pine	Spruce, balsam	2,766
	Big Falls	Spruce		2,042
Northern Lakes (Northern Wisconsin)	Argonne	Northern hardwoods	Balsam, spruce, aspen	8,194
Upper Peninsula (Northern Michigan)	Upper Peninsula	Northern hardwoods	Swamp	5,398
Northern Plains (North Dakota) (inactive)	Denbigh	Sand plains	Dunes	640

FOREST ECONOMICS

The Station's economic studies fall into three main fields:

(a) Forest surveys--to maintain up-to-date information concerning timber resources, timber growth, rate of cutting, etc., for forest lands in a all ownerships in the region. This work is carried on in cooperation with other federal agencies, states, counties, and private owners.

(b) Forest industry wood needs--surveys of wood requirements and long-term trends in wood use, covering the principal forest industries in the region.

(c) Economics of management and utilization--dealing with (1) problems of landownership, organization of forest properties, forest-management possibilities, etc.; and (2) financial aspects of timber growing and harvesting.

A brief summary of progress in the Station's current economic studies follows:

Forest Survey of Northern Minnesota

A new up-to-date inventory of Minnesota forests was started during the winter of 1946-47. During 1947, approximately 2,500,000 acres were inventoried and an additional 600,000 acres mapped. This represents about 15 percent of the area of the 16 counties of northeastern Minnesota.

This survey is a cooperative undertaking, the principal participants being the Minnesota Department of Conservation, the Office of Iron Range Resources and Rehabilitation, the Chippewa and Superior National Forests, the U. S. Office of Indian Affairs, the University of Minnesota Forest School, the boards of supervisors of the northern counties, the Minnesota Forest Industries Information Committee, and the Lake States Station.

Three more or less independent jobs are being done, one under the direction of the Office of Iron Range Resources and Rehabilitation, one under the Minnesota Department of Conservation, and one under the U. S. Forest Service.

Starting in April 1947, the Iron Range Resources and Rehabilitation crew have completed Crow Wing and Aitkin counties and have started work in St. Louis and Itasca counties. The Lake States Station has participated in both the field and office phases of this job. Interest stimulated by this project has resulted in aerial photographing during 1947 of approximately 1,100,000 acres in Itasca County. Additional large areas of northeastern Minnesota will soon be photographed.

The second major project is being conducted by the State Forest Service, in cooperation with the Minnesota and Ontario Paper Company. It has covered about 500,000 acres to date, with an additional 200,000 acres mapped.

The Black River, Savanna, and Burntside units have been completed, and work begun on the Dentaybow and Pelican Lake blocks. The Indian Service has been assisted in the inventory of 80,000 acres in the Northwest Angle.

A third project has been started by the U. S. Forest Service on the Chippewa and Superior National Forests. It is being integrated with the county and state surveys. During 1947 the entire Chippewa National Forest (about 1,300,000 acres gross) was photographed at a scale of 4 inches to the mile on infrared film, using the minus-blue filter, at a cost of about 6 tenths of a cent per acre. The entire area, without regard to ownership, is being type-mapped from the photos.

With some help from the State Forest Service, about 275,000 acres were mapped in 1947 at an average cost of one cent per acre.

The Lake States Station's function has been to coordinate the efforts of federal, state, and private agencies to obtain a complete and accurate inventory of Minnesota forest resources within the next five years. The Station has helped standardize survey measurements and develop new techniques involving use of aerial photos, and has sponsored training courses, devised methods for growth estimation, and helped to prepare tabulations and reports.

Forest Survey of Michigan

Demand for up-to-date and localized timber-resource information in Michigan led to the initiation of a new forest survey in 1946. The objective is to provide accurate forestry statistics, by counties, and, in some cases, by smaller blocks, within the next few years.

The survey procedure varies according to conditions in different parts of the State. In key timber-supply areas, such as Gogebic and Ontonagon counties where a large proportion of the land is held by owners interested in sustained-yield management, new aerial photographs will be made and the entire area mapped intensively to show the extent and location of timber stands.

In other localities, such as Marquette County, where most owners are not yet sufficiently interested in intensive management to invest money in aerial photographs and detailed mapping, a sampling procedure will be followed. No attempt will be made in the latter case to show location of individual timber stands.

Sampling types of survey were made in 1946-47 in Marquette, Dickinson, Baraga, and Iron counties in the Upper Peninsula; and in Eaton, Ingham, Clinton, and Calhoun counties in the Lower Peninsula--covering about 3-1/3 million acres gross, including 2 million acres of forest land. The field crew for these surveys consisted of two men from the Michigan Conservation Department, one to three men from the Lake States Station, and one or more short-term men from the Michigan College of Mining and Technology, Michigan State College, and the regional office of the U. S. Forest Service.

A complete report on the Marquette County survey will be published by the Michigan Department of Conservation early in 1948.

Reports for the southern wood-lot counties will be made for groups of counties, the first of which should be ready by the fall of 1948.

Region-wide Growth Studies

In a region where the forests are largely cut over, knowledge of how fast second-growth timber will grow during the next 10 to 20 years is almost as important as the determination of present merchantable volume. Consequently, a considerable part of the Station's forest-survey effort has gone into collecting and analyzing growth figures.

The standard growth-forecasting procedure in Lake States forest-survey work has been (a) to apply a growth percent to the present merchantable volume in each diameter class; (b) to add the estimated in-growth from trees now below merchantable size; and (c) to discount for expected mortality.

Growth percent to apply to inventory stock tables is computed by multiplying the average 10-year diameter increment by a factor (so-called K factor) developed by the Station. The following calculation illustrates the method:

Second-growth Hardwoods

D.b.h. class	Trees per acre	Volume per acre	Average 10-year diameter increment	K factor	Annual growth	Annual growth per acre
	(1)	(2)	(3)	(4)	(5)*	(6)**
Inches	Number	Bd.ft.	Inches		Percent	Bd.ft.
12	34	2,312	1.42	3.40	4.83	112
14	11	1,276	1.67	2.34	3.91	50
16	3	534	1.91	1.90	3.63	19
18	1	240	2.16	1.60	3.46	8
Total	49	4,362				189

*Product col. 4 x col. 3.
**Product col. 5 x col. 2.

Determination of 10-year diameter growth for each species, diameter class, stand size-class, and stocking class, involves boring many trees, a laborious and time-consuming job. The Station is now analyzing available tree measurements to ascertain whether some other readily measurable factor, with a systematic influence on growth, can be substituted for tree boring.

The most promising development so far is a plan to estimate diameter increment from two factors: (a) approximate tree age, and (b) decadal growth index (the diameter of the tree divided by its age in decades).

The decadal growth factor reflects the combined effect of site, crown class, stand density, etc., and is high if these factors are favorable, low if unfavorable.

In-growth--The calculation of in-growth makes use of an experience table showing for each rate of diameter growth during the last 10 years, the percentage of trees which remain in the same diameter class and the percentage which advance into larger 2-inch classes. An abridged form of the table follows:

Average diameter increment 10 years*	Proportion of present number of trees which:				
	Remain in same d.b.h. class	Advance one 2-inch class	Advance two 2-inch classes	Advance three 2-inch classes	Advance four 2-inch classes
Inches	Percentage				
.2	100				
.6	92	8			
1.0	50	50			
2.0	15	69	16		
3.0	8	42	41	9	
4.0	6	24	39	25	6

*Average growth in diameter of all trees in any 2-inch diameter class.

Mortality--This is estimated from tallies made on the inventory plots of trees which died during the past year.

Forest Industry Wood Needs

In 1947, the Station estimated the quantity of wood used by the pulp and paper and veneer industries. Some of the results of the pulpwood survey are as follows:

(a) In 1946, Lake States pulp mills received approximately 2.9 million cords of wood. About three-fourths, or 2.2 million cords, came from local sources--the balance was imported, mostly from Ontario.

(b) Receipts of spruce totaled 919,000 cords, of which 511,000 were imported.

(c) Aspen receipts were the largest to date and about eight times more than in 1936. The total was 691,000 cords, of which 19,000 were imported. Aspen now exceeds any other pulpwood species in amount produced in the region.

(d) Nearly 27,000 cords of pulpwood were shipped from the Rocky Mountains to Lake States mills. About two-thirds of this was Englemann spruce and one-third lodgepole pine.

(e) 52,000 cords of wood cut in the Lake States were shipped to other regions. About two-thirds of this was aspen and one-third spruce.

(f) Of the pulpwood produced in the region, Minnesota forests supplied about 43 percent, Michigan about 38 percent, and Wisconsin about 19 percent.

Problems of Landownership in Northwestern Wisconsin

The northern Lake States region is passing through a period of industrial readjustment as a result of serious timber depletion. Communities dependent upon sawmills and pulp mills, and rural settlers partly dependent on woods work, are more and more concerned about their future.

There is reason to believe that the situation could be improved if more definite information on location and ownership of the remaining timber resources were available, and if a concerted effort were made to maintain the more vital industries. To ascertain the specific possibilities along this line, a study of a 200-square-mile block of land surrounding Park Falls, Wisconsin, was begun by the Station in the fall of 1947.

One of the complicating factors in sustained-yield forest management in this area is the diverse and unstable ownership of land. This is illustrated by information for Price County, which makes up the central portion of the study area. Of the total county area of 816,215 acres, ownership is divided as follows:

Ownership	Total land	Forest land
	Acres	Acres
Federal	136,606	119,672
State	25,219	22,002
County and subdivisions	152,174	132,802
Farmers	251,428	115,417
Forest industries (1,000 acres or more)	26,809	26,809
Other private	194,296	181,918
Townsites and rights-of-way	29,683	.....
Total	816,215	598,620

The federal lands are almost wholly within the Chequamegon National Forest. They consist mainly of cut-over lands. Although now managed for timber production, they will yield but limited quantities of timber other than aspen for some time to come.

The State lands are handled by three separate State agencies and lack a unified plan of management.

The county lands have been acquired through tax forfeiture, but less than half of them have been organized into county forests. The remainder is in small scattered tracts which are difficult to administer.

Very little of the farm woodland is being well managed for timber production.

Two pulp and paper mills and four large sawmill operators own land in the county. Other holdings of substantial size are those owned by a railroad, two land speculators, several resort operators, and one religious order. By themselves, the forest industry holdings are unable to supply their own mills.

The bulk of the private land is held by a large number of small owners. The average size of holding in one township sampled was 72 acres. In the main, these small holdings are not under management for timber production.

The next steps in the study will be to (a) analyze the wood-supply situation of the local forest industries, (b) determine the forest management possibilities for the several classes of forest landowners, and (c) make specific recommendations to improve the situation.

Financial Aspect of Growing and Harvesting Spruce Pulpwood

The Station cooperated with the Minnesota Division of Forestry and the Minnesota and Ontario Paper Company in a study of the practicability of using spruce pulpwood to smaller top diameters than in current practice. The problem is important because of the growing shortage of spruce. The study was conducted on State land in a 73-acre black spruce swamp near Big Falls, Minnesota.

One-third of the tract was cut to a 4-inch minimum top diameter, the usual utilization standard. One-third was cut to a 3-inch minimum top diameter, and one-third to a 2½-inch top. The significant findings are shown in the table on the following page.

The added cost of cutting smaller sized wood was offset by a reduction in prorated costs of improvements so that total delivered cost was not significantly different in the three kinds of cutting.

The Minnesota and Ontario Paper Company tested the several sizes of wood at their sulphite mill at International Falls. They found that the 2½-inch sticks went through the barkers without loss and in practically the same time as the larger sticks.

The pulp yield by weight was lower from 2½-inch diameter sticks than from 8-inch, but the 5 percent increase in volume represented by such small wood had no appreciable effect on mill-run yields.

Strength tests on the pulp showed no significant differences.

The small-sized wood produced somewhat smaller chips and more sawdust than larger bolts.

The small wood may include somewhat more waste because of a higher proportion of knots.

As a result of this study, the Minnesota Division of Forestry, the National Forests, and several pulp and paper mills are considering adoption of a 3-inch top as the utilization standard for black spruce pulpwood.

Comparison of Average Cost per Cord of Pulpwood Cut to Minimum Top Diameters of 4, 3, and 2-1/2 inches

Minimum top	Volume pulpwood cut per acre 1/			Average cost per cord						
	Standard wood	Additional small wood	Total	Cutting at $1.00 per hour	Skidding	Loading and hauling	Roads, landings, and miscellaneous	Stumpage	Contractor commission	Total
Inches	Cords	Cords	Cords	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
4	15.6	...	15.6	4.35	1.68	3.65	1.45	2.50	1.25	15.69
3	17.1	3.6	20.7	4.47	1.68	3.65	1.19	2.50	1.25	15.55
2½	16.0	4.4	20.4	4.60	1.67	3.65	1.13	2.50	1.25	15.62

1/ 51 acres were partially cut; 22 acres clear cut.

Forest Fire Research

Forest-fire damage cannot be compared for different areas or different years unless it is appraised by uniform methods. At a meeting of State and Federal fire-control men in Milwaukee early in 1947, a uniform method of appraising forest-fire damage was agreed upon. The Station then undertook the revision of the tables used for evaluating damage to second-growth stands in the Lake States. This involved adjustments for current stumpage prices, the recognition of variations due to site, and the inclusion of several additional forest types. A new set of damage tables was then issued by the regional office of the U. S. Forest Service, and these are now in use by the National Forests and State fire-protection organizations.

Tables were prepared showing the rate of fire spread to be expected for each fuel type class at different burning index and wind velocity levels, to enable forest officers to better determine the strength of attack called for under specific conditions. These tables were made available to all State and Federal fire-control personnel in the region.

The administrative branch of the U. S. Forest Service is financing a fire-research assistant who came to the Station on July 1, 1947. This is making it possible to bring up to date the annual summaries of burning conditions, to determine the normal number of days in each danger class by years for the several National Forests, and to establish the relative importance of each class of day in terms of fire occurrence and area burned. The more significant results of this study, based on 11 years' records, are shown in the two accompanying tables.

A study was made of the conditions responsible for the acute fire situation which developed in October 1947. While low humidity and high winds were directly responsible for the severity of conditions, it was shortage of precipitation that made bad fires possible and largely determined where they occurred. A series of maps showing the number of days since rain, at periodic intervals, indicated clearly the development and location of critical areas. (See Station Technical Note No. 286.) Similar maps prepared currently during each fire season would call attention to critical areas and the approach of hazardous conditions.

An analysis of the 1946 State fire statistics for each of the three Lake States showed that year to be somewhat worse than the average of the previous ten years (9.7 as against 7.4 fires per 100,000 acres), but that the size of the average fire was down from 29.7 to 25.6 acres and the area burned (0.25 percent of the area protected) was about equal to the decade average. The cost of fire control in 1946, exclusive of suppression, averaged 4.5 cents per acre. Of the three states, Wisconsin had the best record, burning only 0.05 percent of the area protected and averaging but 5.0 acres per fire. Minnesota, on the other hand, burned 0.51 percent of the area protected and averaged 70.3 acres per fire; while Michigan burned 0.15 percent of the area protected and averaged 12.0 acres per fire. (See Station Technical Note No. 280.)

Average Number of Days per Season in each Burning Index Class for the April 1-October 31 Fire Seasons, 1936-46, inclusive, for each National Forest in the Lake States

National Forest	Burning index class of day[1]							Relative severity[2]
	Safe	Very low	Low	Moderate	High	Very high	Extreme	
	Meter value range							
	(0-1)	(2-3)	(4-6)	(7-12)	(13-24)	(25-49)	(50-100)	
	Number of days							Percent
Chippewa	33	32	40	47	33	24	5	16.4
Superior	29	34	39	54	32	23	3	15.5
Nicolet	34	41	41	45	28	21	4	14.7
Manistee	32	41	43	46	28	20	4	14.6
Chequamegon	39	39	40	44	27	21	4	14.5
Huron	34	37	47	49	25	19	3	13.8
Upper Michigan	36	42	45	44	25	19	3	13.5
Ottawa	50	42	44	39	22	14	3	11.8
Lake States average	36	38	43	46	27	20	4	14.4
Percent of days on which fires occurred	2.5	4.3	8.7	17.7	27.3	41.2	60.7	...
Percent of total burn	0.06	0.3	1.4	4.9	12.8	48.9	31.6	100
Size of average fire (acres)	0.6	1.7	2.8	4.0	10.6	30.9	55.2	(Average 18.4)

1/ Based on maximum daily ratings.
2/ Weighted figure based on the relation to maximum burning conditions.

Average Number of Days in each Burning Index Class for the April 1-October 31 fire seasons, by years, 1936-46

Year	Burning index class of day 1/								Relative severity 2/
	Safe	Very low	Low	Moderate	High	Very high	Extreme	Total	
	Meter value range								
	(0-1)	(2-3)	(4-6)	(7-12)	(13-24)	(25-49)	(50-100)		
	Number of days								Percent
1936	25	40	43	48	30	27	1	(214)	15.1
1937	27	34	42	63	26	20	2	(214)	14.2
1938	29	37	41	60	23	22	2	(214)	14.2
1939	30	42	42	49	24	23	4	(214)	14.9
1940	41	43	39	52	22	16	1	(214)	11.9
1941	37	42	39	53	24	18	1	(214)	12.9
1942	50	35	48	34	24	16	7	(214)	14.1
1943	42	36	49	36	28	17	6	(214)	14.1
1944	46	40	37	30	32	24	5	(214)	15.4
1945	36	41	48	43	28	14	4	(214)	13.2
1946	29	31	40	38	42	26	8	(214)	18.8
11-year Lake States average	36	38	43	46	27	20	4	(214)	14.4

1/ Based on maximum daily ratings.
2/ Weighted figure based on the relation to maximum burning conditions.

Optimum Stocking for Northern Hardwoods under the Selection System of Management

In the past, recommendations for cutting old-growth northern hardwoods have been expressed usually in terms of the proportion of stand to cut or leave. This is, of course, a logical approach as the extent to which a stand is opened up is an important consideration. Another approach is to indicate the volume to leave after cutting in order to obtain optimum growth.

The 15-year growth records for various cuttings on the Upper Peninsula Experimental Forest near Dukes, Michigan, have been analyzed with this in mind. Eight different degrees of cutting were studied, from clear cutting to a light selection cutting from which only about one-fourth of the original volume was removed, and, in addition, an uncut tract was left for comparison. For each degree of cutting the net annual growth was calculated, and the results, curved to show growth for a series of residual volumes ranging from 0 to 9 thousand feet, are given below:

Net Average Annual Growth per Acre, Leaving Different Residual Volumes, for 15-year period

OLD-GROWTH NORTHERN HARDWOODS

Residual stand 10 inches d.b.h. and up	Net average annual growth per acre 2/	
Board feet 1/	Board feet	Percent
0	58	....
1,000	100	10.0
2,000	138	6.9
3,000	170	5.7
4,000	195	4.9
5,000	210	4.2
6,000	216	3.6
7,000	205	2.9
8,000	172	2.2
9,000	98	1.1

1/ Scribner log rule.
2/ Deductions were made for mortality and defect.

For the various residual stands, subsequent growth ranged between 58 and 216 board feet per acre per year. When the growing stock left after cutting was between 4,000 and 7,500 board feet per acre (from 52 to 74 square feet of basal area for trees 10 inches d.b.h. and up) annual growth exceeded 200 board feet per acre. Maximum growth occurred when 6,000 board feet per acre of growing stock were left in the residual stand.

Optimum growing stock for maximum board-foot increment is thus for the first time indicated for Lake States northern hardwoods. Previously, the assumption had been made that board-foot increment, at least for the

Upper Peninsula Experimental Forest, would increase with volume of growing stock almost up to the stocking found in virgin hardwood stands there. That there is a point beyond which there is no reason to hold hardwoods for increased growth is now indicated. For maximum growth, therefore, it seems logical to leave somewhat less than 6,000 board feet per acre at time of cutting, let the stand grow for 10 years or so and then cut again. For the conditions prevailing at Dukes, where average trees are 2½ logs in height and no hemlock is present, this means holding a stand in the range of 4,500 to 7,000 board feet, or about 25 percent less than had previously been considered advisable. Modifications in these stockings would, of course, be necessary for stands on better or on poorer sites. The possible reduction in carrying charges for the smaller forest capital investment, illustrated by these studies, has considerable significance to the owner or manager of a northern hardwoods forest property. The figures given here were obtained on well-stocked plots in good timber. In applying the results to other forest properties, appropriate adjustments should be made for areas of lower productivity or containing swamps and poorly stocked land.

As shown by the above table, growth percent was inversely proportional to residual volume. However, the high percentages for very low growing stock do not represent recoverable volumes because of light stand per acre, small material, and poorer quality. In the range recommended for optimum board-foot increment, the growth percent ranged from 2.9 to 4.5.

Thinning and Pruning in Young Second-growth Hardwoods

Under usual Lake States forestry practices, no cutting is done in second-growth hardwoods until a commercial cut is feasible. This usually requires that a stand be 25 to 30 years old before thinning for fuelwood or chemical wood. The study here reported was a noncommercial timber-stand improvement operation made in 1938 in an 11-year-old stand.

The stand was growing on a good site and consisted of 67 percent sugar maple and 15 percent American elm, with the balance mostly basswood and ironwood. The average dominant tree was 2 inches in diameter and 21 feet in height in 1938.

In a preliminary operation, remnant "wolf trees" were girdled. Then from 360 to 400 trees per acre were selected as crop trees. Thinning to a radius of 2½ feet around each crop tree was carried out on some plots; on others, thinning was to a 5-foot radius. Basswood clumps were thinned so as to leave 2 or 3 of the best trees per clump. Representative trees were pruned on the various plots.

Measurements made eight years after thinning showed that thinning to a 2½-foot radius was too light to give any appreciable increase in diameter growth; however, the 5-foot thinning radius showed strong response. Had the thinning been to about a 4-foot radius or approximately one-fifth of the total height of the average tree, optimum results might have been obtained.

Thinning of basswood clumps gave excellent response. Removal of wolf trees proved of general benefit. The selection of crop trees was quite successful. Of the crop trees selected in 1938, 79 percent were good potential crop trees eight years later.

The most significant result of the pruning was the marked difference in rate of healing, depending on species and diameter of limb at time of pruning. In speed of healing, the tree species ranked as follows: (1) white ash, (2) American elm, (3) sugar maple, (4) basswood. Scars from limbs under one-half inch in diameter healed rapidly; larger limb scars required a much longer healing time.

An appraisal of the financial possibilities of this work must wait until the trees become merchantable for box bolts. The removal of wolf trees, however, appears commercially feasible. When the work was done in 1938 a cash outlay was required; now it is possible to market such trees and break even or possibly make a small profit.

Management of "Farm Forestry" Forties in Second-growth Northern Hardwoods

A considerable acreage of northern hardwood second-growth is owned by farmers. Such stands often include a scattering of large defective trees that were unmerchantable at time of the original logging, a considerable number of pole-sized trees now becoming marketable, and numerous saplings. In order to advise farmers and other small timberland owners of the best methods of managing second-growth wood lots, several 40-acre tracts have been set aside on experimental forests operated by the Station. Harvest cuttings are being made on these "farm forestry" forties annually. Each year a quantity of timber equal to the estimated annual growth on the entire forty is cut on a portion of the forty. The following returns were obtained for the 1947 operation on the Upper Peninsula Experimental Forest near Dukes, Michigan:

Products Removed	Value at roadside
Sawlogs (woods run), 3,120 board feet	$ 98.76
Chemical-wood bolts, 10.0 cords (27.5 tons)	55.00
Cordwood, 5.5 cords	44.00
Pulpwood, 9.6 cords	120.00
Total value	$ 317.76
Less skidding cost	68.60
Net return to owner-operator	$ 249.16
Return per man-hour (227 hours) including stumpage	1.10

A similar "farm forestry" forty cutting was made on the Argonne Experimental Forest near Hiles, Wisconsin, with the following results:

Products Removed	Value at roadside
Logs and tie cuts, 5,800 board feet	$ 235.00
Pulpwood, 5.9 cords	70.50
Fuelwood, 16.0 cords	124.80
Total	$ 430.30
Less expenses (skidding costs, depreciation in equipment, and stumpage)	115.18
Net return	$ 315.12
Returns per hour (233 hours)	1.35

If the farmer owned the land and the stumpage, and paid an average of 30 cents per acre annual taxes, the returns per hour would have netted him $1.73 instead of $1.35.

These two examples illustrate the practicability of farmers cutting their farm woods every year, thus bringing in an annual income. In both instances illustrated above, the State Agricultural Extension Service (Extension Foresters and County agents) cooperated with the Station in publicizing and demonstrating the results of these tests. These farm-forestry activities represent a very important phase of the Station's program on the experimental forests.

Reforesting Poorly Drained Areas

The productivity of Lake States forest lands would be increased greatly if the 2½ million acres of deforested lowland areas were planted. In the past, higher priority has been given to reforestation studies in upland areas. Yet the greatest present and potential timber shortage in the region is in spruce, which grows naturally or can be grown on much of the lowland area.

Although little reforestation of swamps has been tried in the Lake States, two Station studies point the way toward successful reforestation of some lowland sites. In a test in northeastern Minnesota, 2-1 black spruce was bar-planted directly on a heavy growth of live sphagnum moss overlying peat. At the end of eight growing seasons, 68 percent of the trees survived and averaged about 4 feet tall. The shortest trees were on the wettest areas. The results suggest that planting should be confined to the more productive areas, such as swamp borders, avoiding very wet swamps with deep peat.

Another Station study was made in northwestern Wisconsin, on a poorly drained silt loam with a stiff silty clay subsoil, on which previous plantings of white spruce had failed. Trees of 2-2 white spruce, 3-2 Norway spruce, 2-0 black spruce, 2-0 white ash, and 2-2 white pine were planted in furrows, on top of the plow lay, and in scalps. After eight growing seasons, survival of the various species was from 11 to 33 percent higher and the trees were from 6 to 120 percent taller on top of the plow lay than in the furrows or scalps. Based on growth, survival, and vigor, black spruce and white spruce showed best adaptation to the site, with white ash ranking third. Planting on the plow lay may have wide application in large-scale reforestation. Furrowing should be done in the dry season, the year before planting, with a plow effective in cutting the furrow slice so that it will lie flat and avoid leaving an air space.

Plantation Release by Use of Chemicals

Release of plantations from competing vegetation, especially from brush, is an expensive but necessary operation on many productive planting sites in the Lake States. Possibilities of reducing the cost of release through the use of chemical herbicides has been investigated in two localities.

Tests on the Chippewa National Forest in northern Minnesota indicate that 2½ to 7½ pounds per acre of 2,4-D or 50 to 200 pounds per acre of ammate (ammonium sulfamate) sprayed in solution (300 gallons per acre) give reasonable kill of foliage of the following species (listed in order of

susceptibility): hazel, willow, juneberry, aspen, alder, birch, rose, raspberry, oak, and bracken fern. In addition, midsummer application of 3 pounds of 2,4-D or 20 pounds of ammate in 30 gallons of water per acre produced about the same result as a hard-killing frost on low brush sprouts and herbaceous growth, in a newly established red pine plantation.

Alder is an effective obstacle to planting on many of the more productive lowland sites and is almost impossible to remove by ordinary means. A study in northeastern Wisconsin offers promise that alder can be eradicated by cutting the bushes in May and spraying the leaves of the resulting sprouts in late July or August of the same year, using strong concentrations of ammate, or Esteron (a 2,4-D compound) at a strength of .075 percent. The cost, however, is still high--$21 to $30 per acre, at current prices.

Chemical Weed Control in the Forest Nursery

Because it must be done largely by hand, weeding is an important item in forest-nursery costs. That this cost can be cut substantially through the use of chemicals is forecast by Station studies.

Allyl alcohol solution applied at the rate of 7 to 9 gallons per acre, before seeding of red pine beds at the Eveleth nursery in northeastern Minnesota, reduced the weeds by two-thirds. The compound kills weeds both as seeds and young seedlings. It was especially effective on Indian chickweed and common purslane, but clover and erigeron were relatively resistant.

At the Hugo Sauer Nursery in northeastern Wisconsin, No. 1 burner oil, Stoddard solvent, Sovasol No. 5, Weedone, and Esteron 44 were applied to seedling and transplant beds of red pine and white spruce at rates varying from 70 to 215 gallons per acre. Best results were obtained with Stoddard solvent and Sovasol No. 5 (both dry-cleaning compounds), applied full strength at about 120 gallons per acre, which killed over 90 percent of the weeds within two weeks. These sprays were most effective on weeds less than 3 inches in height or spread. Larger weeds and quack grass were not killed. Conifer seedlings were apparently uninjured.

FOREST INFLUENCES - FIELD SHELTERBELTS

Work on the shelterbelt experimental data during 1947 disclosed evidence necessitating an almost complete "about face" in the conception of how field crops are benefited by shelterbelts. The idea that shelterbelts ameliorate drought or can markedly reduce losses of moisture by evaporation and transpiration must be given up. While reduction of wind has this effect when moisture is plentiful, it cannot be expected in the average or very dry year in the Plains country.

Whatever beneficial influence shelterbelts have on moisture conservation is mostly a matter of snow-holding. In fact, crop benefits seem to stem almost wholly from reducing the mechanical power of the wind. It is only through such recognition that crop benefits can be correlated with frequency and velocity of winds from various directions. In addition to snow-holding, soil may also be stabilized or beneficial deposits may be made in the protected area, by winds during the cooler seasons. In the northern two-thirds of the Plains, these are the northerly and westerly winds.

Farther south, shelterbelt benefits diminish markedly, not only because snow is less of a factor, but also because winds which move soil are not confined to any one quarter, although southerly winds predominate. Here the benefits are by preventing abrasion injury to crops which occurs in areas of light soils in the spring. Two-way protection is then called for, or belts established in parallel series, with protection from south winds important.

The above conclusions are based on measurements made on more than 300 fields adjacent to shelterbelts, between the years 1935 and 1941. However, they are clarified by an orientation study to find the key to the best positions for shelterbelts in various parts of the Plains, based on wind records and evaporation-reduction studies, supplemented by additional work on soil evaporation.

COOPERATIVE FARM FORESTRY

Michigan

(In cooperation with Michigan Agricultural Experiment Station)

Studies of improvements in small sawmills continued as the major aspect of the farm-forest research project in Michigan.

The time saved by using air dogs (mechanical devices for holding a log on the carriage and moving it to desired positions), previously developed as a phase of this project, as compared with standard hand dogs, was 6 percent, according to a study made in a small sawmill in southern Michigan. In addition to saving nearly one-half hour per day, the mill owners gave equal value to the improved efficiency, safety, and working life of the setter when air dogs were used.

An edger guide was completed and is ready to be tested. The guide is made by a light which projects a shadow line on the feed cable of the edger. This guide line immediately precedes each saw of the edger and indicates on the boards the lines of saw cut. The guide line in front of the stationary saw will, of course, be fixed but those in front of the two movable saws will also be movable so that when a saw is moved to vary the width of a board, the guide line will move correspondingly. Moving of the guide line will be by a hydraulic attachment.

Wisconsin

(In cooperation with Wisconsin Agricultural Experiment Station and Wisconsin Conservation Department)

In 1946, the Wisconsin farm-forestry research project was reoriented with two primary objectives: (1) to find how to maintain oak in pure stands by natural seeding, and (2) to determine, by cutting studies, the best silvicultural methods for harvesting oak and other important timber types to obtain highest yields and best quality timber.

In 1947, studies were made on 30 oak regeneration areas in southern Wisconsin, as part of the first objective. Although many seedlings of northern red oak and white oak were found in ungrazed woods, these were outnumbered by those of other tree species. Oak seedlings do not seem to develop well; most of them stagnate, hang on for a few years, and eventually die. There is need to determine how much of an opening is required to obtain natural oak regeneration and yet not stimulate too great an invasion of brush species. Animal factors also must be taken into account. For example, mice may be harmful, while squirrels may do more good than harm by distributing acorns. In transition forest types where northern hardwoods are present, it is probably futile to try to maintain oak.

The Wisconsin Timber Harvest forests, areas purchased by the Wisconsin Conservation Department for use by the Extension Service as demonstration areas, are providing facilities for research on the second objective listed above. These tracts of farm-woods size are cut annually, but only to the extent of the growth. During 1947, 100 percent cruises and a series of continuous inventory plots were made on three Timber Harvest forests. This program will be extended in 1948.

Minnesota

(In cooperation with the Minnesota Agricultural Experiment Station)

In 1947, an effort was made to appraise the research work of the past 15 years in southern Minnesota and to outline the problems in most urgent need of attention. The Forester assigned to the farm-forestry research project reviewed the work and experience of various foresters in the area, and discussed forestry problems with farmers, sportsmen, and business people, to get their ideas on what investigations are most needed. Some 14 agencies besides the University of Minnesota and the Lake States Station have an interest in one or another phase of Minnesota farm forestry.

The consensus was that research is needed in the following three broad fields:

1. Woodland management--to determine the effect of different methods of cutting and of pasturing upon the rate of growth and quality of timber, for major timber types (oak, maple-basswood, ash-elm, cottonwood, etc.).

2. Shelterbelts and other tree plantations--including surveys of planting needs and experiments with tree breeding, nursery practice, planting methods, and plantation care.

3. Utilization of home-grown timber products--including a survey of lumber requirements (amount and kind) on typical Minnesota farms, a study of availability of local woods, collection of data on costs and experience.

FOREST WILDLIFE RESEARCH

(Conducted by the Fish and Wildlife Service
in cooperation with the Forest Service)

During 1947, forest wildlife research was directed mainly toward: (1) an appraisal of porcupine damage to forests; (2) tests of germination and direct seeding of repellent-treated jack pine seed; (3) analyzing germination tests of the seeds of wild fruits after evacuation by birds and mammals; (4) study of the effect of moose on the vegetation of Isle Royale National Park; and (5) study of the effect of snowshoe hare clipping on plantations.

Projects with definite conclusions are summarized below:

Porcupine Damage to Forests

Porcupine have been blamed for much damage to forest trees. Little concrete information has been available, however, on the extent of damage and the economic loss. In a case study on the Kawishiwi Experimental Forest in northeastern Minnesota, it was estimated that 36 porcupines caused damage amounting to $16.94 annually to 109 jack pine trees, or an average of 47 cents per porcupine. In addition to jack pine, tree species most commonly damaged are tamarack, white pine, sugar maple, yellow birch, and red pine.

One aspect needing study is the cumulative effect of injuries caused by porcupines. A single animal may cause considerable damage when it works a long time in one location. Areas well supplied with natural dens, such as are provided by overhanging rock ledges or windthrown trees, appear to harbor the greatest populations.

Locally, porcupines may damage plantations severely. Two such cases were investigated: (1) in a 16-year-old Scotch pine plantation in northeastern Minnesota, and (2) in a 12-year-old jack pine plantation in northeastern Wisconsin. The trees in both plantations were similar in size and development. In both cases about 12 percent of the trees were injured by porcupines. Damage is more serious than the percentages indicate, however, as the porcupines seem to prefer the larger trees. In the Scotch pine plantation, the porcupines preferred trees over 3 inches in d.b.h. and 14 feet in height. While few trees are killed outright, many vigorous ones are impaired in growth, form, and soundness. Practical control measures for such situations need to be worked out.

Effect of Moose on the Vegetation of Isle Royale National Park

A large population of moose is found on Isle Royale. What effect does this heavy concentration have on the available browse?

From observations in 13 different parts of the island, it is clear that the browse utilization picture has grown steadily worse since the last survey was made in 1945. Aspen, paper birch, balsam fir, mountain-ash, willow, and red osier dogwood are most commonly browsed, and for the most part are being utilized far in excess of their regenerative ability. In one winter concentration area, even aspen has been barked in large

quantities for the first time, while balsam fir has been practically destroyed. Elsewhere on the island, balsam fir and aspen are dying as a result of overbrowsing.

An airplane count of the moose made in February 1947 showed an estimated population of 614 animals, compared to 510 in 1945. This increase, coupled with the observations on the browse, indicates that the moose population has far exceeded the carrying capacity and that the herd is rapidly approaching another peak and a die-off.

ARTICLES PUBLISHED IN 1947

Aldous, Shaler E.	Some forest-wildlife problems in the Lake States. Station Paper No. 6, 11 pp., mimeo. Jan. 1947.
Smith, Clarence F., and Aldous, Shaler E.	The influence of mammals and birds in retarding artificial and natural reseeding of coniferous forests in the United States. Jour. For. 45(5): 361-369. May 1947.
Arbogast, Carl F.	Young hardwood crop trees can be selected. Tech. Note No. 281, 1 p., mimeo. Oct. 1947.
_____, and Stoeckeler, J. H.	Norwegian forester visits the United States. Jour. For. 45(2):130-131. Feb. 1947.
Chase, Clarence D.	Aspen availability and supply. Lake States Aspen Report No. 2, 15 pp., mult. June 1947.
_____	Southern Minnesota sub-section meets in farm woods. Jour. For. 45(8):616-617. August 1947.
Cunningham, Russell N.	Forest cooperatives in the United States. Reappraisal Report No. 6, USDA, Forest Service, Washington, D. C. 18 pp., mult. 1947.
Demmon, E. L.	How can research help the Michigan timber owner. Station Paper No. 9, 9 pp., mimeo. June 1947.
_____	Review of "Living by the land: conservation with special reference to proper use of the land," by John C. Gifford. 139 pp. illus. 1945. Jour. For. 45(7):519. July 1947.
_____	Lake States forests and the pulp and paper industry. Published as "Available pulp timber stands in the Lake States," a chap. in "Pulpwood stands, procurement, and utilization." TAPPI Monograph series No. 4. Tech. Assoc. of the Pulp and Paper Industry. N. Y. 1947. pp. 40-51. Lake States Timber Digest, pp. 3-4, Oct. 23, 1947; p. 6, 12, Nov. 6, 1947.
Engle, L. G.	Skidding damage by tractors and horses in selective logging of northern hardwoods. Tech. Note No. 277, 1 p., mimeo. July 1947.
Eyre, F. H., and Zehngraff, Paul J.	Spacing of young red pine. Station Paper No. 8, 6 pp., mimeo. June 1947.

Gevorkiantz, S. R. — Review of "Tables for estimating board-foot volume of timber," by Clement Mesavage and James W. Girard. Jour. For. 45(1): 56. Jan. 1947.

_____ — Taper table for aspen (Populus tremuloides)--well-stocked stands. Tech. Note No. 266, 1 p., mimeo. Jan. 1947.

_____ — Guide for estimating defect in northern hardwoods. Jour. For. 45(2): 128-130. Feb. 1947.

_____ — More about numerical expression of stocking in terms of height. Jour. For. 45(3): 203. March 1947.

_____ — Growth and yield of jack pine in the Lake States. Station Paper No. 7, 11 pp., mimeo. May 1947.

_____ — Pulpwood volumes increased by closer utilization. Jour. For. 45(7): 511. July 1947. Tech. Note No. 274, 1 p., mimeo. April 1947.

_____ — Converting volumes between International 1/4-inch rule and Scribner rule. Lake States Timber Digest, p. 13, Nov. 6, 1947. Tech. Note No. 283, 1 p., mimeo. Oct. 1947.

Horn, A. G. — Timber cutting is a big business in Beltrami County. Blackduck American, Sec. 2, p. 14. April 24, 1947.

_____ — Vencer log production in the Lake States continues at high level. Tech. Note No. 284, 2 pp., mimeo. Oct. 1947.

_____, and Scholz, Harold F. — Cross tie industry problems in the Lake States. Lake States Timber Digest, p. 3-4, 8, July 17, 1947; pp. 10-13, July 31, 1947.

Johnson, Richard C. — Lead indicating device for circular sawmill headrigs. Tech. Note. No. 267, 1 p., mimeo. Jan. 1947.

Mayne, Howard W. — Beltrami county lands are a valuable resource. Blackduck American (Forest Fire Prevention Edit.), p. 16, April 24, 1947.

_____ — Landownership in sixteen northeastern Minnesota counties. Tech. Note No. 282, 2 pp., mimeo. Oct. 1947. Lake States Timber Digest, p. 5, Nov. 6, 1947.

Mitchell, J. A. — Forest fires in the Lake States in 1946. Tech. Note No. 280, 2 pp., mimeo. July 1947.

_____ — Forest fires in Indiana. Jour. For. 45(8): 570-574. Aug. 1947.

_____ — Forest fire statistics: their purpose and use. Fire Control Notes 8 (4): 14-17. Oct. 1947.

_____ — Fire loss in Lake States area. Lake States Timber Digest, p. 10, Oct. 23, 1947.

Neetzel, John R. — Southern Minnesota produces 54.2 million feet of lumber in 1946. Miss. Valley Lumberman 78(8): 9. Feb. 21, 1947.

Olsen, Lucille P. — 1946 Michigan lumber production continues at high level. Tech. Note No. 271, 1 p., mimeo. April 1947.

_____ — Wisconsin lumber production increased in 1946. Tech. Note No. 272, 1 p., mimeo. April 1947.

_____ — Minnesota sustains high level lumber production in 1946. Tech. Note No. 273, 1 p., mimeo. April 1947.

Roe, Eugene I. — What is a pine plantation worth? Amer. Forests 53: 28-29, 44. Jan. 1947.

_____ — Thinning in cedar swamps. Tech. Note. No. 279, 1 p., mimeo. July 1947.

Rudolf, Paul O. — Machine-made forests. U. S. Dept. Agric. Yearbook 1943-1947: 843-846.

_____. — The reforestation in Lake States area. Lake States Timber Digest, p. 8, 10. Mar. 13, 1947.

_____ — Review of "Forestry practice--a summary of methods of establishing forest nurseries and plantations with advice on other forestry questions for owners, agents, and foresters." Forestry Commission Bul. No. 14, 91 pp., 1946. Jour. For. 45(4): 297-298. April 1947.

_____ — How much reforestation is needed in Wisconsin? Tree Tips, p. 1, 2. April 1947.

_____ — Measuring forest nursery stock. Tech. Note No. 275, 1 p., mimeo. April 1947.

Rudolf, Paul O. — Plan now for planting. Blackduck American (Forest Fire Prevention Edit.), p. 14. April 24, 1947.

_____ — Wisconsin leading in reforestation. Lake States Timber Digest, p. 8. June 5, 1947.

_____ — Tree species planted in Lake States. Lake States Timber Digest, p. 9. July 31, 1947.

_____ — Machines for forest planting. Canadian Pulp & Paper Assoc., Woodlands Section Index No. 943 (F-2), 5 pp., illus. Sept. 1947.

_____ — Minnesota needs huge tree-planting program. Minn. Conservation Volunteer 10(61): 14-17. Nov.-Dec. 1947.

Sands, Waldo — Aspen for containers. Lake States Aspen Report No. 10, 12 pp., mult. July 1947.

Stoeckeler, J. H. — Yield table for cottonwood plantations. Tech. Note No. 268, 1 p., mimeo. Jan. 1947.

_____ — Review of "Forest soils and forest growth," by S. A. Wilde. Bot. Gaz. 108:458. Mar. 1947.

_____ — The northern Wisconsin forest research center. Lake States Timber Digest, p. 5, 15. March 13, 1947.

_____ — When is plantation release most effective? Jour. For. 45(4): 265-271. April 1947.

_____ — Review of "The destruction of the soil in Palestine," by F. H. Taylor, Gov. of Palestine, Soil Conservation Board. Bul. 2, 19 pp., 4 pls. Jerusalem 1946 (?). Jour. For. 45(5): 378-379. May 1947.

_____ — Too many jack pines per acre pose a real problem for Nosinee foresters. Tree Tips, p. 3. June 1947.

_____ — Federal experimental forest is established. Timber Prod. Bul. (Upper Mich. and No. Wis.) No. 51, p. 7. June 28, 1947.

_____ — Planting poorly drained wet sites. Tech. Note No. 276, 1 p., mimeo. July 1947.

Stoeckeler, J. H. — Review of "Forest Soils," by Harold J. Lutz and Robert F. Chandler, Jr. 514 pp., illus. 1946. Jour. For. 45(8): 606-608. Aug. 1947.

Zasada, Zigmond A. — Aspen properties and uses. Lake States Aspen Report No. 1, 9 pp., mult. May 1947.

Zehngraff, Paul J. — How many small fence posts to a cord? Tech. Note No. 269, 1 p., mimeo. Jan. 1947.

_____ — Possibilities of managing aspen. Lake States Aspen Report No. 21, 23 pp., mult. June 1947.

_____ — Response of young aspen suckers to overhead shade. Tech. Note No. 278, 1 p., mimeo. July 1947.

_____, and Zasada, Z. A. — Prospective markets for small wood. Blackduck American (Forest Fire Prevention Edit.), p. 1. April 24, 1947.

Zillgitt, W. M. — Second-growth woodland on farms can return an annual income. Tech. Note No. 270, 1 p., mimeo. Jan. 1947.

_____ — Stand changes following selection cutting. Lake States Timber Digest, p. 5. June 5, 1947.

_____ — Log grade following selection cutting in northern hardwoods. Tech. Note No. 285, 1 p., mimeo. October 1947.

_____, and Gevorkiantz, S. R. — Estimating cull in northern hardwoods. Lake States Timber Digest, pp. 12-13. Feb. 13, 1947.

PERSONNEL

Lake States Forest Experiment Station

Administration - Elwood L. Demmon, Director
Jerry Roch, Administrative Assistant
Charlotte L. Devine, Purchasing Clerk
Helen A. Woodworth, Clerk-Stenographer
Dorothy A. Keller, Clerk-Stenographer
Mary H. Seaman, Fiscal Accounting & Auditing Clerk
Rosemary Miller, Stenographer
Adele M. Gibney, Stenographer

Forest Management - Francis H. Eyre, Silviculturist, In Charge
Paul O. Rudolf, Silviculturist
Suren R. Gevorkiantz, Silviculturist
Lucille P. Olsen, Statistician
Evelyn C. Paquin, Statistical Clerk (to 6-30-47)

Field Stations

Northern Minnesota Research Center, Grand Rapids, Minnesota
Lawrence P. Neff, Forester, In Charge
Paul J. Zehngraff, Silviculturist
Zigmond A. Zasada, Forest Economist
Eugene I. Roe, Silviculturist
Junior A. Hess, Forester (Transf. to R-6, 6-15-47)
Lee S. South, Timber Management Assistant
Carl E. Sundquist, Clerk

Northern Wisconsin Research Center, Rhinelander, Wisconsin
Joseph H. Stoeckeler, Forester, In Charge
Carl Arbogast, Jr., Silviculturist
Gordon R. Condit, Silviculturist (to 7-17-47)
Nelson T. Samson, Forester
Edward R. Stoltz, Clerk

Upper Peninsula Experimental Forest, Dukes, Michigan
Walter M. Zillgitt, Silviculturist, In Charge
La Mont G. Engle, Forester
Wilho A. Salminen, Timber Management Assistant

Denbigh, Denbigh, North Dakota (inactive)

Forest Influences - Carlos G. Bates, Silviculturist

Forest Fire Control - J. Alfred Mitchell, Silviculturist
John S. Crosby, Forester

Forest Economics - Russell M. Cunningham, Forest Economist, In Charge

Economics of Management and Utilization
Howard W. Mayne, Forest Economist

Forest Survey
Arthur G. Horn, Forest Economist
Clarence D. Chase, Forester
H. Gilbert White, Forest Economist (on LWOP)
Grover A. Choate, Forester (Transf. to R-9, 7-15-47)
Paul C. Guilkey, Forester
Harvey M. Seeley, Forester

Statistics
Suren R. Gevorkiantz, Silviculturist

Cooperative Farm Forestry

Michigan - Waldo M. Sands (Transf. to FPL, 9-10-47)
John W. Creighton, Agent

Minnesota - John R. Meetzel, Forester

Wisconsin - Harold F. Scholz, Silviculturist

Forest Biology (Fish & Wildlife Service, U. S. Department of Interior)
Laurits W. Krefting, Biologist
Robert S. Gensch, Biologist (Transf. to Billings, Montana, 6-30-47)
Shaler Aldous, Biologist (Transf. to Washington 1-15-47)
Elizabeth K. Houska, Clerk-Stenographer (to 8-1-47)